DEVELOPMENT AND VALIDATION OF A SAFETY AND HEALTH PERFORMANCE MODEL FOR LOW COST HOUSING

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For my beloved husband,

Engr. Rufaizal Bin Che Mamat

and

My dearest father and mother,

Ramli bin Hj Bajuri and Kamisah binti Hj Safar

and

My sweet children,

Nur Wardina Safiyah, Nur Ainnatul Wardah, Ahmad Thaqif Waldan

and Arissa Wadhiah

May ALLAH protect and bless us all.

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“ May ALLAH Bless Us All To Achieve Excellence in Life

ABSTRACT

Sustainable building and construction practices in Malaysia are primarily aimed at improving the safety and health performance of buildings while minimizing its impact on resources and the natural environment. Thus, a comprehensive understanding of the factors that contribute to safety and health performance of our built environment is essential. The aim of this study is to develop a building safety and health performance (BSHP) model, focusing on the safety and health performance factors of low cost housing in Malaysia. These factors include the architecture, building services, external environment, operation and maintenance, and management approaches. The influence of these factors on perceived personal responsibility towards adopting a BSHP model for low-cost housing in Malaysia was also studied. This study was undertaken in two stages. Firstly, literature on existing safety and health practices related to low-cost housing and facilities were reviewed to identify factors that influence health and safety performance. Quantitative data were gathered to assess the suitability of the factors based on experts judgement and survey. Data obtained were statistically examined using the exploratory factor analysis (EFA) and the proposed model was identified. Secondly, quantitative data were gathered through a main survey involving 308 respondents to test the research model validity and the proposed hypothesis using the Partial Least Squares (PLS) tool. Results reveal that the five identified constructs have a direct positive effect on safety and health performance, as well as perceived personal responsibility. Furthermore, perceived personal responsibility ($\beta = 0.563$) towards safety and health performance has the highest beta value, followed by building services ($\beta = 0.212$), architecture ($\beta = 0.155$), operation and maintenance ($\beta = 0.128$), management approaches ($\beta = 0.124$), and external environment ($\beta = 0.117$). In testing the validity of models, results found BSHP model had a good model fit with R^2 of 0.342 and in line with experts validation results. The BSHP model can inform the public of the relative risks regarding the safety and health of low cost housing. It can also help building owners, developers, and government bodies to develop more informed and socially responsible decisions to improve building safety and health performance.

ABSTRAK

Rekabentuk dan amalan pembinaan yang mampan di Malaysia adalah bertujuan untuk meningkatkan prestasi keselamatan dan kesihatan bangunan di samping meminimumkan kesannya terhadap sumber dan alam semula jadi. Oleh itu, pemahaman yang menyeluruh terhadap faktor-faktor yang menyumbang kepada keselamatan dan prestasi kesihatan bangunan adalah penting. Kajian ini bermatlamat untuk membangunkan model prestasi keselamatan dan kesihatan bangunan (*BSHP),* di mana memberi tumpuan kepada faktor yang menyumbang kepada prestasi keselamatan dan kesihatan khusus bagi perumahan kos rendah di Malaysia. Faktor-faktor ini termasuk seni bina, perkhidmatan bangunan, persekitaran luar, operasi dan penyelenggaraan, dan pendekatan pengurusan. Pengaruh faktor tanggungjawab peribadi ke arah mengamalkan model *BSHP* khusus bagi perumahan kos rendah di Malaysia juga dikaji. Kajian dijalankan dalam dua fasa. Pertama, kajian terdahulu mengenai amalan keselamatan dan kesihatan yang sedia ada berkaitan dengan perumahan kos rendah dan kemudahannya telah dikaji untuk mengenal pasti faktor-faktor yang mempengaruhi kesihatan dan prestasi keselamatan bangunan. Data kuantitatif dikumpul untuk menilai kesesuaian faktor berdasarkan penghakiman dari pakar dan soal selidik. Data soal selidik telah dianalisis menggunakan *exploratory factor analysis (EFA)* dan cadangan model telah dikenalpasti. Kedua, data kuantitatif dijalankan melalui kajian soal selidik utama yang melibatkan 308 responden untuk menguji model kajian dan hipotesis yang dicadangkan menggunakan alat kajian *Partial Least Squares (PLS).* Keputusan mendapati lima faktor telah dikenal pasti mempunyai kesan positif secara langsung kepada keselamatan dan prestasi kesihatan bangunan, serta faktor kesedaran tanggungjawab individu. Tambahan pula, kesedaran tanggungjawab individu (β=0.563) terhadap prestasi keselamatan dan kesihatan mempunyai nilai beta yang tertinggi, diikuti perkhidmatan bangunan (β=0.212), senibina (β=0.155), operasi dan penyelenggaraan (β=0.128), pendekatan pengurusan (β=0.124) dan persekitaran luaran (β=0.117). Dalam ujian relevan ramalan model, model *BSHP* mempunyai nilai model patut baik R^2 dengan angkali 0.342 dan selari dengan pengesahan daripada pakar. Model *BSHP* akan memberi maklumat kepada orang ramai mengenai risiko keselamatan dan kesihatan perumahan kos rendah. Ia juga membantu pemilik bangunan, pemaju, dan badan-badan kerajaan untuk membuat keputusan yang lebih tepat dan bertanggungjawab untuk meningkatkan prestasi keselamatan dan kesihatan bangunan.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Sustainable development is fast emerging as one of the main priorities of the construction industry in Malaysia. It has a complex relationship with the quality of housing – quality of housing has huge impacts on the economic, social and environmental dimensions of sustainable development (Said *et al.*, 2009). There is a need for a sustainable strategy for housing development in Malaysia, especially in the National Housing Policy (NHP), as the country aspires to become a developed nation by the year 2020. Under this policy, Malaysians of all income levels, particularly the low-income group, would have accessibility to adequate, affordable and quality shelter (Idrus & Siong, 2008; Sufian & Mohamad, 2009; Ubale, Martin, & Wee, 2012)

The government's commitment towards the provision of low-cost housing is evident from the announcements made by its leaders and from the government's annual budgets and development plans since the First Malaysia Plan (1966–1970). The involvement of the private sector began during the Second Malaysia Plan (1971–1975) when the government realized the importance of the role of the private sector in ensuring an adequate supply of low cost housing for the country (Ubale *et al.*,

2012). Under the Seventh (1996-2000) and Eighth Malaysia Plan (2001-2005), the Malaysian government was even more committed to providing adequate, affordable and quality housing for all Malaysians, particularly the low income group (Shuid 2009, 2010). Consequently, a total of RM4.2 billion was allocated for low-cost public housing during the Eighth Malaysia Plan (2001-2005) and RM9.4 billion during the Ninth Malaysia Plan (2006-2010). This effort continued in the Tenth Malaysia Plan (2011-2015) when the Government pledged to provide 78,000 units of affordable housing specially for the low income group. A fund of RM500 million was also allocated for the repair and maintenance works of public and private low-cost housing (Shuid, 2010).

During the period of rapid economic growth in the 1990s, the public and private sectors actively built low-cost houses and almost achieved the total number of unit targeted. Programmes such as the Public Low-Cost Housing Project (PLCHP) and the Public Housing Program (PHP) were implemented in order to meet the needs of a rapidly growing population in the urban areas (Ministry Of Housing and Local Government of Malaysia, 2009). In this regard, Ubale *et al.*, (2012) suggested that affordable housing for the low income group must be viewed as an integral part of an integrated housing and community development, and its provision must take into account various elements such as the government's role as the facilitator; building design and construction methods; physical environmental elements and comfort levels; health, safety and security measures; long term maintenance requirements; replaceability of structural components; statement layout and infrastructure; and appropriate materials.

However, as low-cost housing remains to be seen primarily as a government's responsibility and a loss-making venture, it is unlikely for developers to consider quality and performance in their low-cost housing projects (Zaid & Graham, 2011; Bajunid & Ghazali, 2012). Indeed, studies like Abidin (2009) have recognized factors that impede the implementation of sustainable practices. They are a lack of legislation and enforcement; a lack of knowledge and awareness; and a passive industry culture. These factors in turn lead to other problems such as dilapidation, poor provision of services, bad location and others (Omar, 2008; Zainal *et al.*, 2012; Karim, 2012; Zain, 2012).

In response to a growing awareness of building safety and health, a simple and practical modelling framework to understanding of the factors that contribute to safety and health performance of low cost housing has been proposed. Due to this reason, the main purpose of this research is to define safety and health performance, identify its dimensions and to inform the development of safety and health measurement. Furthermore, the aim of such modelling framework is to provide an objective indicator on building performance so that the indicator can be used as a reference for construction practitioners and community building management.

1.2 Problem Statement

It is well known that the construction sector contributes enormously towards Malaysia's economic activity, employment and growth (Ministry of Housing and Local Government of Malaysia, 2009). As population density increases, so does demand for residential homes, especially for low-cost housing. The rate of urbanisation in Malaysia has increased rapidly from 25% in 1960 to 72% in 2010 (Zainal *et al.*, 2012). An assessment by the Administrative Districts, Malaysia (2010) showed that population density in Kuala Lumpur in 2010 was 7,089 per unit of land area (Administrative Districts, Malaysia, 2010). As a result, demand for affordable housing in the cities has increased, causing an acute shortage of affordable housing. Since the Third Malaysia Plan, the number of completed low-cost housing projects has not achieved its target (Shuid, 2009; Bajunid & Ghazali, 2012). In fact, during the Eighth Malaysia Plan, the total number of low-cost housing completed was 197,649 units compared to 230,000 units needed (Ministry of Housing and Local Government of Malaysia, 2009). Many private developers were engaged to meet the housing need. However, these developers built the low-cost houses purely out of quota requirements as they are unprofitable ventures. Consequently, occupants of low-cost housing are constantly faced with many problems such as sub-standard quality, maintenance, comfort levels, health, safety and security services (Zaid & Graham, 2011; Bajunid & Ghazali, 2012).

In the context of low-cost housing construction in Malaysia, the Construction Industry Development Board (CIDB) Industry has introduced Construction Industry

Standard 1 (CIS 1:1998) and Construction Industry Standard 2 (CIS 2:1998) – these are standards that specify the minimum design and planning requirements for low-cost houses in Malaysia (Sufian & Ibrahim, 2011). Despite the enforcement of these regulatory measures, safety and health problems persist in many low-cost housing projects. Even public low-cost housing is not excluded from these management problems. Unsatisfactory housing conditions and the reluctance of property managers to carry out safety and health inspections are evident from the large number of complaints and reports (Karim, 2012; Husin *et al.*, 2012; Fire & Rescue Department Malaysia, 2012). A study conducted by Karim (2012) on low-cost housing quality in Shah Alam, Malaysia found that the performance of low-cost housing is affected by various issues such as quality of construction materials and sanitary system, provision of facilities and maintenance, location, and social problems. Similarly, Omar (2008) identified that the root causes leading to poor housing quality are related to housing layout and design, the surrounding environment, the level of maintenance, location, provision of amenities and the quality of building materials. Poor housing conditions cause structural deterioration, falling building fragments, fire and other safety hazards and various health problems (Keall *et al.*, 2010; Wong *et al.*, 2006).

Urban cities are typically crowded with high-rise buildings, many of which are residential buildings. Apart from the constructed quality of these buildings and their surrounding environmental quality, the quality of Facility Management (FM) services such as repair and maintenance, cleaning, aesthetic value, safety, privacy and amenities are among the problems and risks affecting their social health and the environment (Omar, 2008; Isnin *et al.*, 2012; Latfi, Karim, & Zahari, 2012). Another study conducted by Zainal et al. (2012) also investigated the relationship between housing conditions and the quality of life in low-cost housing in the Klang Valley. They found that housing for the urban poor lacks in physical qualities such as design, size and materials used and in other qualities such as location, landscape and availability of public amenities and services. The performance of these facilities, in effect, is influential to the health, safety and enjoyment of the residents.

From the findings of previous studies, it is expected that if enough information on building safety and health is provided in the market, safer properties would be highly beneficial for the country's environment, economy and society. It is worth investigating further on whether our buildings are sufficiently safe and healthy

for their occupants and the general public. Therefore, modelling framework must be developed to determine the safety and health indicators for new and existing building with the focus on the prevention of safety and health problems (Akasah, Abdul & Zuraidi, 2011; Akasah & Alias, 2009).

1.3 Research Questions and Hypotheses

In response to the issues highlighted above, in this section, we develop a list of research questions, which guide the research. All of the proposed hypotheses are used to evaluate our conceptual propositions with respect to the empirical data collected. We seek answers to our research questions by analyzing the data by using systematic and rigorous approaches that are specifically tailored for this study.

Research question 1: What factors are contributing to safety and health performance of low-cost housing in Malaysia?

A review of the literature suggested that current design and practices of Malaysia's low-cost housing are skewed towards minimizing the environmental and resource impacts and improving the safety, health, and productivity of a building's occupants. Information on safety and health performance of our buildings are readily available. For these reasons, this study does not pose the question of how buildings affect human safety and health, rather it investigates the factors contributing to the safety and health performance of a building. In order to answer research question 1, the constructs of building safety and health are conceptualized based on a literature review and quantitative (expert judgment). This approach is to widen the academic and construction professionals' perspective and to develop further knowledge on building safety and health performance. Furthermore, building safety and health modelling framework is developed in order to provide better understanding of the factors that will be operationalised in this study. In addition, this research question will address the completeness of the building safety and health performance (BSHP) model by identifying relevant factors to be included in a model, and hence the first hypothesis has been developed to support this endeavor. To seek answers to these

questions, we have established and formalized our first hypothesis guided by our research agenda.

Hypothesis 1: The factors identified in the literature potentially contributing to safety and health performance of low-cost housing in Malaysia.

The second of research questions intend to operationalise the factors (building safety and health performance constructs) of the building safety and health modelling framework. In addition, it aims to develop reliable and valid measurement scales in order to develop a BSHP model for Malaysia's low-cost housing. Content validity, construct validity and reliability analysis of identification survey were assessed in order to developed a significant measures in initial BSHP model for Malaysia's low-cost housing. Therefore, the initial BSHP model is highly important, as it will be used for testing the validity of the BSHP model.

Research question 2: Are all existing building safety and health performance constructs and attributes applicable in the BSHP model?

The second hypothesis relies on the argument that our constructs such as architecture are related with the identified attributes that are potentially contributing contributing to safety and health performance of low-cost housing in Malaysia. To seek answers to these questions, we have established our second hypothesis:

Hypothesis 2: There is an observable relationship among the building safety and health performance constructs (latent) and our attributes (indicators) in the BSHP model?

The next group of research questions aim to rigorously validate the model by examining the relationship between building safety and health performance constructs. This includes two important research questions:

Research question 3: Are all building safety and health performances measures significant in the BSHP model?

Research question 4: Is the BSHP model valid for measuring the safety and health performance for low-cost housing in Malaysia?

This research question refers to the validation process of the BSHP model. The model will be tested according to the guidelines for reflective construct

validation in SmartPLS. In detail, a set of hypotheses has been developed from the literature and based on existing theory, which has been conceptualised in a initial model that proposes causal relationships of constructs (Please see Figure 4.11 on page 115) . Furthermore, the structural model representing the hypothesised relations between building safety and health performance constructs will be empirically tested based on quantitative data. In addition to statistical analysis, the validity of the BSHP model was tested by engineers, architects and building surveyor.

Hypothesis 3:

H_1 = The factors means of escape, means of access, structural and finishes integrity, building material, amenities, space functionality and fire resistant construction have a positive influence on safety and health performance with conditions related to architecture.

H_2 = The factors electricity system, lighting, ventilation, air conditioning, plumbing, sanitary services, fire services and lift services have a positive influence on safety and health performance with conditions related to building services.

H_3= The factors emergency services, external hazards, location, air quality, peaceful environment and aesthetics have a positive influence on safety and health performance with conditions related to external environment.

H_4 = The factors building peripherals, structural and finishes integrity, building services conditions, fire compartment integrity and security maintenance have a positive influence on safety and health performance with conditions related to operation and maintenance.

H_5 =The factors emergency evacuation plan, documentation and evaluation, security management, occupant safety management and waste and cleaning services have a positive influence on safety and health performance with conditions related to management approaches.

H_6 = Safety and health performance is positively related to perceived personal responsibility.

1.4 Research Objectives

The aim of this research is to develop a BSHP model of low-cost housing in Malaysia. In addition to these aims, the objectives of this study are:

i) To identify factors contributing to safety and health performance of low-cost housing in Malaysia.
ii) To assess the significant factors that explain the determinants of the BSHP model for Malaysia's low-cost housing.
iii) To develop BSHP model for low-cost housing in Malaysia.
iv) To validate the adequacy of the model that explains determinants of BSHP model for low-cost housing in Malaysia.

1.5 Research Scope

Housing in Malaysia can be characterized as low-cost, low medium-cost, medium-cost and high-cost (National Housing Department, 2013). Due to time and resource constraints, the subject of this study was confined to low-cost housing flats (>5 storey), by measuring the factors that contribute towards safety and health performance (Figure 1.1). They include low-cost housing flats in small towns and sub-urban areas, whereby a flat refers to a multi-storey building which houses many residential units, usually with provision of basic facilities such as lifts and maintenance services (Institut Bank-bank Malaysia, 2010). In Malaysia, private low-cost housing flats include 5-storey and more than 5-storey walk-up flats (Bajunid & Ghazali, 2012). Flats are chosen for two reasons. First, multi-storey residential blocks are common in Malaysia due to urbanization. As of end of 2012, a total of 467,185 units of low-cost flats have been built by the public and private sectors (National Property Information Center, 2012). However, minimal research and development in the field of sustainable low-cost housing has been conducted in Malaysia, especially for high-rise flats (Zaid & Graham, 2011).

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